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Abstract

ON TWO SCHEMES FOR NUCLEAR REACTOR CALCULATIONS

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Two mathematical schemes for nuclear reactor calculations have been prepared at the Theoretical Physics and Reactor Calculations Division of the Junta de Energía Nuclear (JEN).

The tools for the first scheme are the following programs, all coded at JEN for the UNIVAC USS-90 computer:

a) ISLERO

This program solves either the P_1 or B_1 approximation to the one-dimensional, multigroup slowing down Boltzmann equation in an infinite homogeneous slab. The 54 energy groups range from 10 MeV to 0,625 eV. Few-groups constants, to a maximum of three groups, are obtained by averaging over the flux spectrum. Input data are the isotopic composition, the geometrical buckling and the self-shielding factor.

b) PROMETEO-I and II

These programs solve the Wigner-Wilkins and the Wilkins differential equations, respectively. The thermal constants are averaged over the so obtained flux spectrum. Input data are the isotopic composition, the geometrical buckling, and temperature.

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c) EDIPO-I and II

These programs solve the one dimensional, several-group diffusion equations. EDIPO-I is a few-group (-4) program, for a maximum of 20 regions and 199 mesh points. The corresponding values for EDIPO-II are, 16, 4 and 49, respectively. An interesting feature of the last program is that of allowing up-scattering in the last three groups. The conventional method of flux sinthesis has been applied to sinthesize two dimensional fluxes by combining the results of one dimensional problems. Isotopic composition in clusters follows from the thermal flux fine distribution according to the Pershagen-Carlvik approach. A generalized Selengut method has been developed by taking advantage of the possibility offered by EDIPO II of having up-scattering in the three last energy groups. In this way interference fenomena between thermal spectra can be taken into consideration.

The whole theoretical scheme has been applied to the substitution experiments carried out in Aquilon II (Saclay) and to the exponential experiments carried out at the Physics Division of JEN, as a part of the DON Project Programme a natural uranium carbide -heavy water- organic reactor system. In all calculations the resonance self-shielding factor was left free as an adjustable parameter. Four-groups diffusion theory was used throughout.

The second scheme differs from the first essentially in that the weighting functions for averaging cross sections are not the flux spectra, but the product of importance and flux spectra. As a first step, the program CAMPEADOR has been developped to be used on the USS-90 machine. This program solves the multigroup (16 groups) diffusion equations and their adjoints for a finite or infinite homogeneous medium. The condensation to a given number of groups (16) takes place by averaging cross sections as said above. EDIPO-I and II are then used for reactivity and neutron flux distribution alculations. The schme been checked against experimental and theoretical results for fast neutron systems as given in the literature.